U.S. VIRGIN ISLANDS NUTRIENT STANDARDS PLAN
October 13, 2010

INTRODUCTION AND OVERVIEW

The U.S. Virgin Islands (USVI) Code establishes the Department of Planning and Natural Resources (DPNR) as the environmental protection/regulatory agency. The US Environmental Protection Agency (EPA), under the auspices of Region 2, has delegated responsibility for environmental protection to the DPNR's Division of Environmental Protection (DEP). Under the Water Pollution Control Grant, pursuant to §106 of the Clean Water Act (CWA), DEP is entrusted with the task of monitoring territorial marine waters and controlling discharges into those waters. The water quality monitoring in USVI began in the early 1970's and it has gradually evolved into the present Ambient Monitoring Program which is overseen by DEP.

There is concern that excessive inputs of nutrients from point and nonpoint sources are negatively impacting USVI's coastal marine waters. However, there is little information on the temporal and spatial distribution of nutrients from either natural or impacted coastal waters. Under the authority of the CWA §304(a), the EPA provides assistance to government entities to develop numeric nutrient criteria for estuaries and coastal waters. In a November 14, 2001 memo, Geoffrey Grubbs, the Director of EPA's Office of Science and Technology provided States and Territories with specific guidance on the development and adoption of nutrient criteria into water quality standards. One of the suggestions in the memo was the development of nutrient criteria plans which would be mutually agreed upon between a standards-setting body and EPA. In a May 25, 2007 memo, Benjamin H. Grumbles, the EPA's Assistant Administrator, further encouraged all States, Territories and Authorized Tribes to accelerate their efforts and give priority to adopting numeric nutrient standards or numeric translators for narrative standards for all waters in States and Territories that contribute nutrient loadings to our waterways. This document, serving as a Nutrient Standards Plan, describes USVI's present and future approaches to addressing nutrient over-enrichment in estuarine and marine waters.

DPNR generated this Nutrient Standards Plan in an effort to outline its approach to attaining numerical nutrient, Total Phosphorous (TP) and Total Nitrogen (TN), criteria for the USVI estuarine and coastal waters. This document is being developed as a living document which will be modified as program resources dictate. The USVI Nutrient Standards Plan has been developed in close conjunction with EPA Region 2. The DPNR submitted its original Nutrient Plan to EPA on September 25, 2007. The Plan was accepted as a mutually agreed upon document on November 14, 2007. In this document, the DPNR provides revisions to its original Plan to incorporate ongoing research and provide a more detailed schedule for the development and adoption of nutrient criteria. This current version of the Nutrient Standards Plan will be amended as analytical methods are further researched and confirmed.

Overall Project Goal/Outcome
This Nutrient Standards Plan is driven by an overall project goal or outcome of developing numerical nutrient criteria for USVI coastal waters. The projects associated with nutrient criteria development were designed to fulfill Nutrient Criteria Development Funding and coincide with

DPNR's Multi-Year Monitoring Strategy. The development of numerical nutrient criteria will allow DPNR to better assess its coastal waters through Total Maximum Daily Loads (TMDLs), Territorial Pollutant Discharge Elimination Systems (TPDES), and Water Quality Certificates.

Overall, the USVI plans to develop and adopt into its WQS numeric nutrient criteria (TP and TN) for estuarine and coastal waters. Adopted criteria will be protective of both, recreational and aquatic life uses including sensitive coral reef and mangrove ecosystems. A schedule for the development and adoption of criteria is included at the end of this document.

Water Classification
The USVI consists of 3 main and 57 smaller islands (Figure 1). Its surface freshwater is limited to approximately 240 small ponds and intermittent streams (guts). According to 29 V.I. CODE § 225, a gut is defined as a natural or constructed waterway or any permanent or intermittent stream. Since these guts are generally dry there is no need to establish nutrient criteria for those waterways. Thus USVI will not initiate the process of nutrient criteria development for these waterbodies. On the other hand, there are more than 600 sq. miles of territorial marine waters in the USVI, thus, DPNR will focus on those waters to develop numeric nutrient criteria. Waters of USVI exist in one of three classes (Figure 2):

1. Class A:
   - *Best usage of waters:* Preservation of natural phenomena requiring special conditions, such as the Natural Barrier Reef at Buck Island, St. Croix and the Under Water Trail at Trunk Bay, St. John.
   - *Legal limits:* St. Croix: within 0.5 miles of the boundaries of Buck Island's Natural Barrier Reef. St. John: Trunk Bay.

2. Class B:
   - *Best usage of waters:* For maintenance and propagation of desirable species of aquatic life (including threatened and endangered species listed pursuant to section 4 of the federal Endangered Species Act) and for primary contact recreation (swimming, water skiing, etc.).
   - *Legal limits:* Any coastal waterbody not classified as Class A or Class C is considered a B waterbody.

3. Class C:
   - *Best usage of waters:* For maintenance and propagation of desirable species of aquatic life (including threatened and endangered species listed pursuant to section 4 of the federal Endangered Species Act) and for primary contact recreation (swimming, water skiing, etc.).
   - *Legal limits:* St. Thomas: St. Thomas Harbor beginning at Rupert Rock and extending to

Haulover Cut; Crown Bay enclosed by a line from Hassel Island at Haulover Cut to Regis Point at West Gregerie Channel; and Krum Bay. <u>St. Croix</u>: Christiansted Harbor from Fort Louise Augusta to Golden Rock; Frederiksted Harbor from La Grange to Fisher Street and seaward to the end of the Frederiksted Pier; Hess Oil Virgin Islands Harbor; and Martin-Marietta Alumina Harbor. <u>St. John</u>: Enighed Pond Bay.

Assessment Units

Coastal waters of USVI are divided into four different assessment units (Figure 3):

1. *Embayments* – waters surrounded primarily by land; restricted mixing and circulation; most susceptible to water quality problems.

2. *Nearshore* - at least some portion of water unit in contact with land; mixing may not be restricted; longshore currents help to disperse pollutants; may be impacted by point and non-point sources from land.

3. *Offshore* – waters units bounded on all sides by water; generally thought to be well mixed; any inputs from land are likely to be highly dispersed prior to reaching these waters.

4. *Requiring TMDL* - waters which do not meet Virgin Islands Water Quality Standards and are therefore considered impaired.

For the process of nutrient criteria development, priority is given to embayments and nearshore waterbodies, based on proximity to land and sources of pollution as well as monitoring priorities of the 303(d) list.

Coral Reef Ecosystems:

DPNR recognizes the intrinsic value and importance of healthy corals reef systems. Coral reef ecosystems are ecological assets, providing habitat for diverse and abundant marine species, primary production and trophic complexity. There are also social and cultural values attributed to coral reefs, especially in island communities like the USVI. Because of the potential impact of nutrients on the coral reef ecosystems, nutrient criteria will need to be tailored to protect these special ecosystems. To this end, we will continue to work with the local universities to assess the impact of nutrients on these ecosystems.

DPNR's efforts to assess the overall health of the USVI Coral Reef Ecosystem include collaborative projects funded by USEPA Region 2 entitled the Regional Applied Research Effort (RARE) Nutrient Surveys. The work that is being done in collaboration with EPA's Office of Research and Development as part of the RARE project is part of larger monitoring efforts; which includes tracking coral health condition and determining if there is a correlation between coral health and changes in water quality.

NUTRIENT CRITERIA DEVELOPMENT PROCESS

In August 2001, EPA has published a Technical Guidance Manual for Estuarine and Coastal Marine Waters. This manual provided states, tribes and other authorized jurisdictions with methods for developing nutrient water quality criteria for estuarine and coastal marine waters. Under the CWA, States and Authorized Tribes are to establish water quality criteria to protect designated uses. State and Authorized Tribal decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. While this guidance does not present nutrient criteria for a specific estuaries or coastal waters, it constitutes EPA's scientific recommendations regarding defensible approaches for developing regional nutrient criteria.

In the process of nutrient criteria development, USVI will follow recommendations included in the 2001 Guidance document. First, DPNR will establish a range of nutrient (phosphorus and nitrogen) concentrations in reference and impacted waters. Reference sites will be determined as DPNR continue to work on the development of nutrient criteria. Second, DPNR will analyze data to establish 75th percentile values for class A, B, and C waters. These values will become a significant component in the process of nutrient criteria development. Once the data is analyzed, DPNR will determine if it is necessary to develop different nutrient criteria for the water classes (A, B, and C) as relates to estuarine and coastal criteria. Once criteria are developed, it would be incorporated into the WQS Revision Process.

There are several projects that comprise our Nutrient Standards Plan; these projects will be completed at various times over the next several years. This plan details already completed, presently ongoing, and anticipated future steps toward deriving nutrient criteria for our estuarine and marine waters. EPA recommends that states establish criteria for both nutrients [nitrogen (N), and phosphorus (P)] along with response variables (chlorophyll a and/or water clarity). We believe that our numerical values, based on historical data as well as data collected presently and in the future, will accurately represent not-to-be-exceeded nutrient levels necessary to protect the designated uses (best uses) of our waters. We are actively working to develop and adopt numeric nutrient criteria, however, given the technical and resource constraints, criteria development is expected to take time.

We anticipate the adoption of numerical standards. However, adoption of numerical standards is a number years away. Before numerical standards can be adopted, further research must be conducted which includes multi-year sample collection, which is subject to DPNR's staff and resource availability. As a result, the schedule for development and adoption of numeric nutrient criteria provided at the end of this document is tentative and will depend on available staff and funding resources.

USVI EXISTING PROGRAM TO ADDRESS NUTRIENTS

Current Criterion

Existing USVI water quality standards, adopted in June 2010, include both a general narrative criterion (sec. 186-1(b) and 186-1(c)1-6) and a numeric criterion for phosphorous of 50 µg/L, or 0.05 mg/L (12 V.I. R. & REGS., Chapter 7, §186, 1998 and Supp. 2005). The USVI does not currently have a numeric criterion for nitrogen.

Nutrient enrichment may negatively impact water quality resulting in coastal marine waterbody impairments and adverse impacts to biota (EPA 2001, Gibson et al. 2005). In the USVI, there is concern that excessive inputs of nutrients - specifically nitrogen and phosphorus - from point and nonpoint sources are negatively impacting coastal marine waters and ecosystems (e.g. Jeffrey et al. 2005). However, there is little quantitative information on nutrient concentrations or patterns of temporal and spatial nutrient distribution relating to either natural conditions or nutrient enrichment conditions for our coastal marine waters.

Past/Completed Efforts

Preliminary (2000-2005) Studies: The USVI initiated coastal and estuarine nutrient sampling efforts in 2000. The goal of these preliminary efforts was to develop a sufficient database to be used for nutrient criteria development, with special emphasis on examining the relationship of the level of nutrients in the water column and algal growth on the coral reefs. Because of the potential impact of nutrients on the tropical ecosystems (i.e., coral reefs, mangroves, etc.), nutrient criteria will need to be tailored to protect these special ecosystems. DPNR will continue to work with the local universities to assess the impact of nutrients on these ecosystems.

In 2001, DPNR received funds from EPA to support a Nutrient Criteria Development Program. These funds supported the procurement of equipment for nutrient analysis. A facility was established in 2002 at the University of the Virgin Islands' MacLean Marine Science Center.

In March of 2003, DPNR-DEP began collecting water samples for nitrogen and phosphorus around St. Croix, which is the largest island (37 km long by 10 km wide) and the most southern of the USVI, located about 58 km south of St. Thomas and St. John (Figure 1). On St. Croix, there are a variety of known or suspected sources of nutrients into coastal surface waters. Point sources include a municipal sewage discharge and a rum distillery outfall – both located off the southwest coast. Diffuse or nonpoint sources are seasonal inputs in the form of stormwater runoff.

In addition, preliminary work involved the opportunistic collection of water samples for nutrient analysis during regularly scheduled ambient water quality monitoring surveys completed between March 2003 and December 2005. From March 2003 to December 2005, a total of 137 and 118

samples were collected and analyzed for TKN and TP, respectively. Samples were obtained from 43 St. Croix ambient monitoring stations (Figure 1).

Preliminary Data Analysis: In 2006, DPNR performed an interim analysis on the DEP's nutrient dataset for USVI waters (Toller and Villanueva-Mayor 2006). This analysis identified two primary concerns regarding the Nutrient Criteria Development Program. First, the generally low levels of nutrients observed in VI's coastal marine waters raised concerns that analytical detections limits were not sufficiently sensitive, and it was therefore questioned whether the most appropriate laboratory procedures were being utilized. Second, the analysis showed that the lack of a stratified sampling design precluded statistical tests and seriously compromised interpretation of nutrient datasets.

Nutrient Work Group: To follow up on the concerns, a Nutrient Work Group, comprised of local and federal scientists, was convened to provide DEP-DPNR with recommendations on strategic decisions regarding nutrient studies. The group recommended: 1) to continue nutrient data collection using existing methods but attempt to improve data reliability through evaluation of method detection limits (MDLs) and independent verification of laboratory results; and 2) to include in the future nutrient studies a stratified sampling design to distinguish various waterbody types based upon the degree of hydrographic restriction and distance from shore (i.e. estuaries, embayments, open coasts, pelagic waters).

In FY2008 and FY2009 DPNR received the CWA 106 Supplemental funding from EPA to continue work on nutrient criteria development in collaboration with the University of the US Virgin Islands. To follow up on the Nutrient Work Group a recommendation, a Memorandum of Agreement (MOA) was drafted to outline the terms of this new project (Supp. 106 grant; Objectives 1 and 2). MOA initiated collaboration of DPNR with the University of the Virgin Islands (UVI) and included two objectives relative to nutrient criteria development process. First objective is already completed and it is described in more details below. Second objective is described in "Ongoing and Future Efforts" section later in the document.

EPA 106 Funding (Objective 1): *Implement Additional Quality Control Measures for Nutrient Analyses*

The Method Detection Limit (MDL) approach (40 CFR 136 of the Federal Register) was used to determine the detection limit for TKN and TP. However, based on results of nutrient analysis done by UVI and ORD laboratories during the St. Croix survey, DPNR considered replacing TKN with TN, nitrate, and nitrite, for consistency reasons. Samples were analyzed at the University of Virgin Islands, MacLean Marine Science Center nutrient laboratory using EPA methodology, which required modification for use with seawater. In addition to routine calibration curve determinations, calculation of MDL required analysis of seven "fortified" nutrient samples. The MDL were calculated twice: once prior to and once following completion

of environmental sampling (see Objective 2, described below for details).

Once the USVI has confirmed the analytical methods to be used for further nutrient studies, MDLs will be developed for additional parameters.

The Quantitation Limit (QL) was determined for TKN and TP. The exact protocol for determination of QL was refined through further discussions with the University. The proposed QL method was used to analyze five replicates of samples with known concentrations or "spikes" that approached detection limits. For TKN, the detection limit was reported at 0.05 mg/l and the TKN spikes were prepared at 0.05 mg/l and 0.10 mg/l. For TP, the detection limit was reported at 0.02 mg/l and the TP spikes were prepared at 0.02 mg/l and 0.04 mg/l. Data from replicates were used to determine the 95% confidence intervals for results at these concentrations.

Based on the confirmed analytical methods to be used for further nutrient studies, DPNR may need to develop QLs for TN.

Existing DEP procedures for QA/QC specify that duplicate samples are taken at a frequency of at least 10% of environmental samples, and that the agreement between sample and duplicate must be greater than 30% Relative Percent Difference (RPD). These procedures were followed for all proposed environmental sampling. To assess the accuracy of the laboratory results, duplicates of environmental water samples were collected for analysis by an independent laboratory. These water sample "splits" were obtained during field activities (Objective 2) at a frequency of 20% (two sets of ~ eight samples). Splits samples were analyzed by the EPA laboratory in Edison, New Jersey. DEP calculated the average RPD between the results reported by the two laboratories.

This objective was met during EPA-ORD's OSV Bold Surveys in November to December 2007 and February to March 2009. Identified MDLs and QLs will be used in work to be completed under the second objective of this study.

PLAN TO REVISE AND EXPAND NUTRIENT CRITERIA PROGRAM

Following the foregoing recommendations, as a first step, we plan to address three specific objectives that will support nutrient criteria development for coastal marine waters of the USVI. These results will allow us to determine 1) the operational detection limit for Total Kjeldahl Nitrogen (TKN) and Total Phosphorus (TP) using existing analytical procedures; and 2) whether these analytical procedures are appropriate for nutrient monitoring of USVI waterbodies. In 2007, objective 2 were completed during EPA ORD's OSV Bold Surveys. Analytical procedures of USVI laboratories were compared with the EPA ORD Contact Lab. Both analyses were found to be comparable. Additionally, DEP may contemplate the use of dissolved inorganic nitrogen and dissolved inorganic phosphorus as viable parameters pending additional funding/resources are

allocated.

DPNR will also continue to evaluate how TKN relates to the criteria for TN.

Ongoing and Future Efforts:

CWA 106 Supplemental Funding (Objective 2). *Nutrient Concentrations in Different Types of Waterbodies:*

Results obtained under the Objective 1 will be used in this task. A stratified sampling design will be used to investigate differences in nutrient concentration among waterbody types. We will make *a priori* delineation of St. Croix waters into four types of waterbodies: Estuaries & Bays, Semi-Enclosed Bays, Nearshore Open Coastal Waters, and Pelagic Waters. In the present study, we do not plan to identify un-impacted or "reference" nutrient conditions. Rather, we wish to obtain preliminary information on the range of nutrient concentrations that may be observed within a given type of water. These data are necessary to interpret data from future comparative studies of impacted versus un-impacted waters - data which may be obtained from very different waterbody types.

	Waterbody Type	Waterbody Description	Proposed No. of Samples Per Year
I.	Estuaries & Bays	Lagoons, estuaries, and relatively enclosed bays	20
II.	Semi-Enclosed Bays	Relatively open bays which are fronted by barrier reefs	20
III.	Nearshore Open Coastal Waters	Outside of bays or barrier reefs and within 1 nm of shore	20
IV.	Pelagic Waters	Beyond shelf break but within 3 nm of shore (territorial seas)	20

Delineations of waterbody types will follow those of Battelle (2003), which may be modified as needed. Sampling locations will be selected in advance by generating random coordinates within pre-defined GIS polygons representing waterbody types. Surface grab samples will be collected during two sampling periods, with 10 samples taken per waterbody type per period for a total of 80 nutrient samples. Five routine water quality parameters (temperature, salinity, pH, dissolved oxygen, turbidity) will be recorded at each sampling location as per DEP Standard Operating Procedures for ambient water quality monitoring. Observed benthic habitat type will be recorded.

Water samples will be analyzed for TKN and TP at the UVI MacLean Marine Science Center. Data analyses will be performed by DEP staff. Differences in TKN and TP concentration among

waterbody types will be examined using a one-way analysis of variance (ANOVA) following appropriate data transformation. If ANOVA indicates significant differences then post hoc pair-wise examinations will be made using two-tailed *t*-tests. Similarly, differences in N:P ratios among waterbody types will be investigated using ANOVA. Correlation between TKN and TP concentrations will be examined by linear regression. Multiple linear regressions will also be used to examine possible correlations between nutrient concentration and routine water quality parameters.

At the time of analysis the University of the Virgin Islands (UVI) did not have the capability to analyze TN. UVI recently, however, acquired analytical equipment which allows for TN analysis.

The proposed experimental design was reviewed by an EPA-contracted statistician, at the request of the Nutrient Work Group. He recommended that DEP explore the use of non-parametric statistical tests (e.g. rank sum tests) which are available in commercially available software packages such as *Statistica*. DEP will follow statistician's recommendations for transformation procedures and for the identification of the most appropriate non-parametric statistical tests. DEP may contemplate increasing the number of samples collected for each waterbody type, if additional funding is allocated. This objective will be completed during a 2-year project to be untaken by the University of the US Virgin Islands.

RARE Project: *Relate Nutrient Concentration to Coral Health – to be completed by December 2010.*

In addition to examining nutrient concentrations in varying waterbody types, the USVI's Nutrient Criteria Development Program will attempt to examine the relationship between nutrients concentrations in the water column and its relationship with coral reef health. Relating coral reef condition to ambient water quality will help U.S. EPA and USVI establish methods that support the mandates of the Clean Water Act. This will, in turn, enhance reef sustainability

In 2007, Bill Fisher of Office of Research and Development's (ORD's) Gulf Ecology Division published the Stony Coral Rapid Bioassessment Protocol for use in the USVI. The bioassessment surveys were completed by the ORD for St. Croix in November to December 2007 and for St. John's and St. Thomas Islands in February to March 2009.

St. Croix Survey: On August 24, 2007, DPNR sent to Region 2 letter of commitment to assist ORD with bioassessment survey scheduled for November-December, 2007 in the area of St. Croix. This assistance will be funded with the nutrient grant ($14,000) provided to DPNR in 2003 (extended through September, 2008). DPNR assistance will include water sample collection, processing, and shipment to the ORD laboratory for nutrient (TP, TN, nitrate, nitrite, ammonia) analysis. In addition, split samples will be collected and sent to the University of Virgin islands. Nutrient data from both (ORD's and UVI's) laboratories will be compared to verify the QA/QC

readiness of the VI's laboratory for future nutrient work.

St. John and St. Thomas Survey: On August 24, 2007, DPNR sent to Region 2 letter of commitment to assist ORD with the bioassessment survey scheduled for November 2008 in the area of St. Thomas and St. John Islands (in support of the FY'08 Regional Applied Research Effort (RARE) Program proposal). The RARE proposal includes the two-year project to characterize the potential relationship of water quality (including nutrients), sediment, and biological resources (coral reefs and reef communities) along the coastlines of St. John and St. Thomas islands.

There are two more monitoring events being scheduled before the RARE project is completed. DPNR anticipates the data collection to be completed by December 2010 and statistical data analysis completed by June 2011. Results of this study will be a significant component during the development of nutrient criteria to protect sensitive coral reef ecosystems.

ESTIMATED SCHEDULE FOR CRITERIA DEVELOPMENT AND ADOPTION

DPNR recognizes that adoption of nutrient criteria is a lengthy process. Therefore, the following tentative schedule has been developed in an effort to facilitate Total Phosphorus and Total Nitrogen Criterion adoption for the Territorial Estuaries and Coastal Waters by the end of FY2015. **This schedule is tentative and may be revised/adjusted as resources dictate**.

Tasks	Target Completion Date	Actual Completion Date
Planning for criteria development		………………
Collection of information and data	FY2013	
Analysis of information and data (criteria calculation)	Mid FY2014	
Proposal of draft criteria to EPA	FY2014	
Public review/comments process; legal review	Mid FY2015	
Adoption of criteria into USVI's WQSR	FY2015	
Submission of adopted criteria to EPA for approval	Mid FY2016	

Relation of Proposed Nutrient Study to Monitoring Strategy

The USVI Multi-Year Water Quality Monitoring Strategy specifically identifies two measurements of nutrient concentration as core indicators of water quality: TKN and TP (DEP 2006). The strategy also clearly states DEP's goal of developing "in a scientifically defensible manner" nutrient criteria for waters of the USVI (DEP 2006, page 22) and it provides an approximate timeline for nutrient criteria implementation (pages 24-27). The two studies (objectives 1 and 2) previously described will provide essential scientific data in support of

nutrient criteria development. Specifically, they will enable us to answer the following questions: First, what is the operational detection limit for TKN and TP using existing analytical procedures? Second, are these detection limits appropriate for nutrient monitoring of four types of USVI waterbodies?

Linkage of Proposed Nutrient Study to Designated Uses and TMDL Development

The Virgin Islands Code provides a narrative description of the designated best usage of waters which applies to all waters of the USVI. The narrative designates *best usage* as "for maintenance and propagation of desirable species of aquatic life (including threatened and endangered species listed pursuant to section 4 of the federal Endangered Species Act) and for primary contact recreation (swimming, water skiing, etc.)."

This broad definition is interpreted to mean that waterbody impairment occurs whenever one of two usages is compromised: either the quality of contact recreations is reduced (because of decreased aesthetic value or increased health risks) or desirable species (or their habitats) are impacted. Nutrient enrichment may lead to eutrophication which will reduce the aesthetic value (water clarity, odor) of a waterbody. Therefore, excessive nutrient inputs may jeopardize the designated best use of primary contract recreation. Elevated nutrient levels may also have deleterious effects on coral reefs and seagrass beds (e.g. LaPointe 1997, LaPointe et al. 2004), and may therefore jeopardize the designated best use of a waterbody for propagating desirable species.

At present, it is not clear how many USVI waterbodies experience excessive inputs of nutrients. Assessment and monitoring studies of nutrients in USVI coastal marine waters are essential to understand the extent of anthropogenic nutrient enrichment. Nutrient datasets may form a critical cornerstone for future Total Maximum Daily Loads (TMDL) development. For example, nutrient monitoring data collected by the National Park Service was utilized in the formulation of a TMDL for Great Cruz Bay, St. John (Tetra Tech 2005). That analysis indicated that elevated phosphorus inputs were primarily responsible for phytoplankton blooms, elevated pH, and reduced water clarity in Great Cruz Bay.

Evaluation of the results of the above referenced efforts will lead to decision making on the best future opportunities towards nutrient criteria development. This may include additional sampling, more site-specifically focused studies, etc. Based on the results of the above described efforts, we will be able to provide a list of more specific milestones along with the schedule for nutrient criteria development process.

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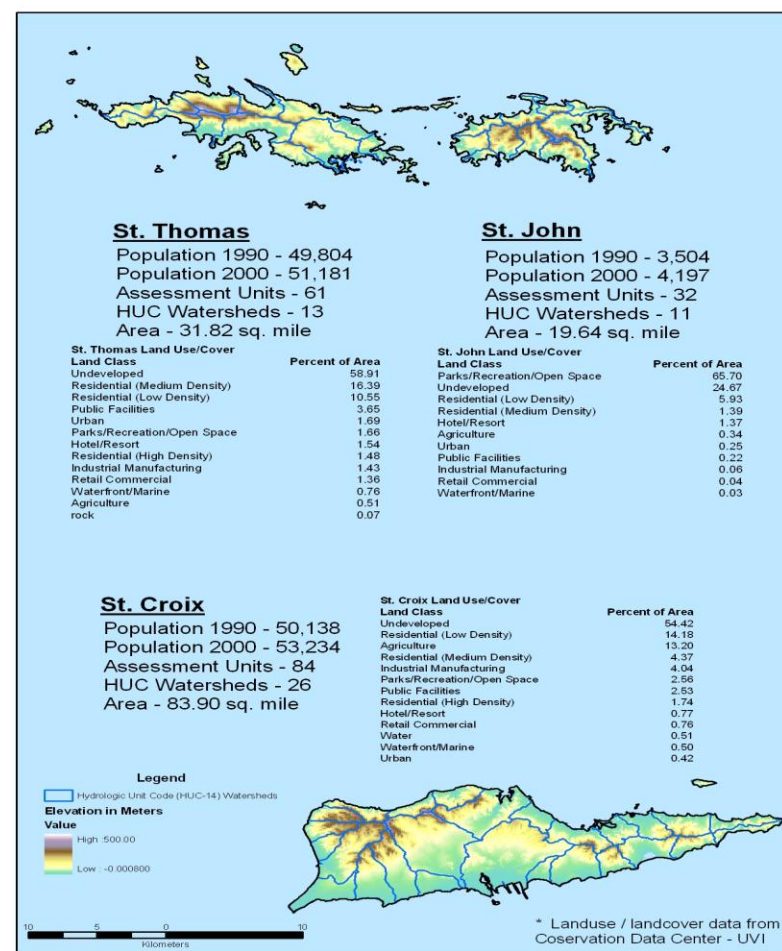
Figure 1. The U.S. Virgin Islands.

St. Thomas
Population 1990 - 49,804
Population 2000 - 51,181
Assessment Units - 61
HUC Watersheds - 13
Area - 31.82 sq. mile

St. Thomas Land Use/Cover

Land Class	Percent of Area
Undeveloped	58.91
Residential (Medium Density)	16.39
Residential (Low Density)	10.55
Public Facilities	3.65
Urban	1.69
Parks/Recreation/Open Space	1.66
Hotel/Resort	1.54
Residential (High Density)	1.48
Industrial Manufacturing	1.43
Retail Commercial	1.36
Waterfront/Marine	0.76
Agriculture	0.51
rock	0.07

St. John
Population 1990 - 3,504
Population 2000 - 4,197
Assessment Units - 32
HUC Watersheds - 11
Area - 19.64 sq. mile

St. John Land Use/Cover

Land Class	Percent of Area
Parks/Recreation/Open Space	65.70
Undeveloped	24.67
Residential (Low Density)	5.93
Residential (Medium Density)	1.39
Hotel/Resort	1.37
Agriculture	0.34
Urban	0.25
Public Facilities	0.22
Industrial Manufacturing	0.06
Retail Commercial	0.04
Waterfront/Marine	0.03

St. Croix
Population 1990 - 50,138
Population 2000 - 53,234
Assessment Units - 84
HUC Watersheds - 26
Area - 83.90 sq. mile

St. Croix Land Use/Cover

Land Class	Percent of Area
Undeveloped	54.42
Residential (Low Density)	14.18
Agriculture	13.20
Residential (Medium Density)	4.37
Industrial Manufacturing	4.04
Parks/Recreation/Open Space	2.56
Public Facilities	2.53
Residential (High Density)	1.74
Hotel/Resort	0.77
Retail Commercial	0.76
Water	0.51
Waterfront/Marine	0.50
Urban	0.42

Legend
Hydrologic Unit Code (HUC-14) Watersheds
Elevation in Meters
Value
High :500.00
Low -0.000800

* Landuse / landcover data from
Coservation Data Center - UVI

Figure 2. Classes of Territorial waters in the USVI.
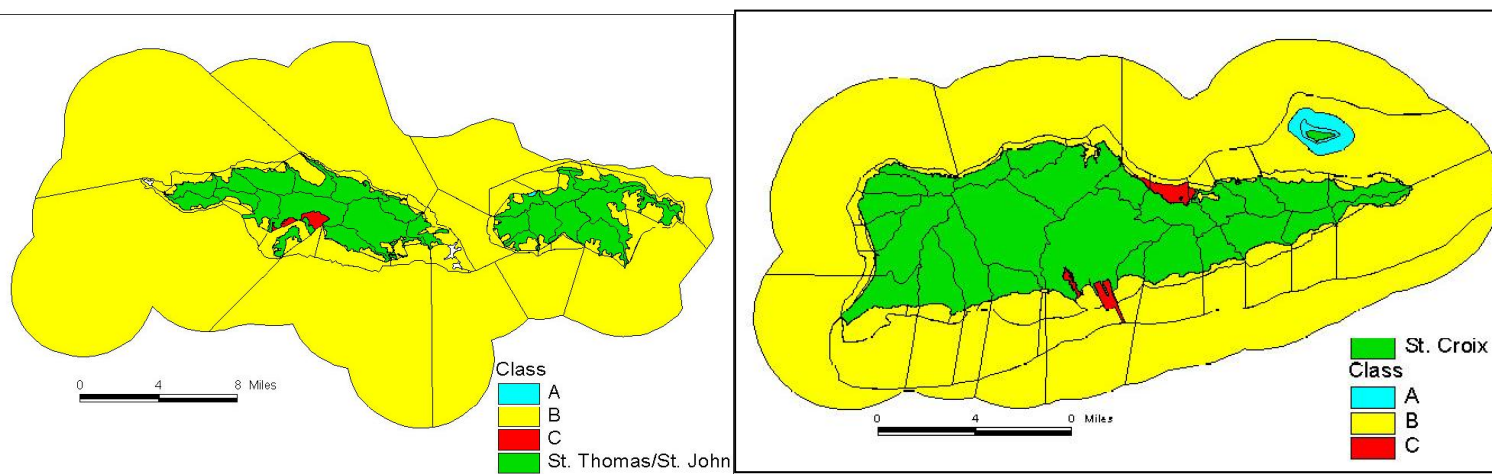
Figure 3. Waterbody Classification and Level of Efforts.

Waterbody Classification and Level of Effort
- TMDL: Intense
- Embayment: Routine/Intense
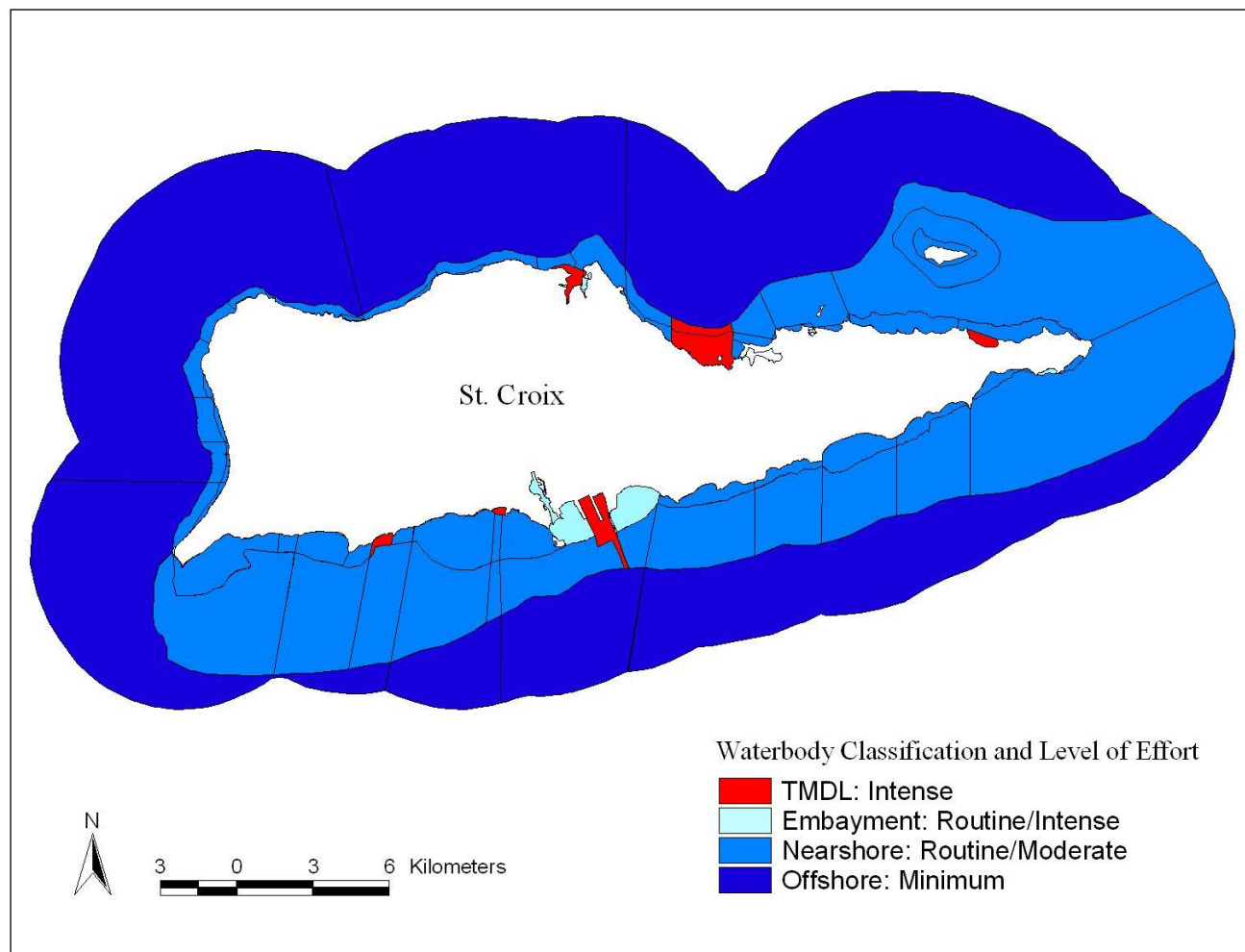- Nearshore: Routine/Moderate
- Offshore: Minimum

Figure 4. Distribution of stations sampled for nutrients in 2003-2005study. Stations were selected from the Ambient Monitoring fixed station network.